



NIOSH HEALTH HAZARD EVALUATION REPORT

HEA # 2004-0100-2946
Transportation Security Administration
Washington-Dulles International Airport
Dulles, Virginia
December 2004

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health



PREFACE

The Hazard Evaluation and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health (OSHA) Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employers or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

HETAB also provides, upon request, technical and consultative assistance to federal, state, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Mark M. Methner, Lisa J. Delaney, and Randy L. Tubbs of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies. Analytical support was provided by DataChem Laboratories and Ardith Grote of Division of Applied Research and Technology. Desktop publishing was performed by Robin Smith. Editorial assistance was provided by Ellen Galloway.

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For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Highlights of the NIOSH Health Hazard Evaluation

Evaluation of exposure to contaminants and noise in the checked bag screening area

In July 2004, NIOSH conducted a health hazard evaluation at the Dulles International Airport Transportation Security Administration (TSA) baggage screening area. We measured levels of air contaminants and noise in the passenger baggage screening area.

What NIOSH Did

- We took air samples for carbon monoxide, oxides of nitrogen, diesel exhaust, and hydrocarbons.
- We measured noise levels.

What NIOSH Found

- All air samples were within recommended levels.
- General exhaust ventilation in the East Baggage Basement was provided by ceiling-mounted ducts and floor-mounted intake vents. The other baggage basements used outdoor air intake vents.
- Workers used pedestal-mounted fans in the screening areas for additional comfort.
- Floor-mounted intake vents were often blocked with trash/debris.
- Drain lines from the L3 screening machines were improperly routed into the floor-mounted ventilation intake ducts.
- Most noise levels were within acceptable limits.
- A conveyor within the West Baggage Basement created an unnecessary noise source (loud squeak).
- A “baggage jam” alarm in MU-2 (remote) created an unnecessarily long duration noise source.
- Airline tugs can run on several different types of fuel sources.

- Some airline tugs appeared to be “out of tune,” idled erratically and generated high levels of exhaust products.
- Airline employees often left tugs idling when not in use.

What TSA Managers Can Do

- Work with airlines to make sure tugs are maintained and kept in good running order to keep emissions low.
- Ask airlines to have their employees turn off tugs when not in use.
- Improve housekeeping practices, especially in the floor vent areas.
- Re-route cooling drain lines from L3 machines away from the floor vents, to a more suitable receptacle.

What the TSA Employees Can Do

- Report changes in noise levels to TSA management.
- Use trash receptacles to keep work areas free of debris.
- Ask tug operators to shut off tugs when loading/unloading baggage.



What To Do For More Information:

We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report #2004-0100-2946



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Mark M. Methner, PhD, CIH
Lisa J. Delaney, MS
Randy L. Tubbs, PhD

SUMMARY

On January 21, 2004, the National Institute for Occupational Safety and Health (NIOSH) received a health hazard evaluation (HHE) request from the Transportation Security Administration (TSA) at the Washington-Dulles International Airport (IAD) in Dulles, Virginia. The HHE request concerned health hazards from exposure to contaminants found in exhaust emissions of tug and jet engines and noise from tugs, jets, conveyors, and baggage carousels in the checked baggage screening area. Reported health problems included respiratory distress, dizziness, possible hearing loss, and headaches. On July 12-13, 2004, NIOSH investigators collected ambient air and personal breathing zone (PBZ) air samples for carbon monoxide (CO), nitrogen dioxide (NO₂), nitric oxide (NO), diesel exhaust particulate (measured as elemental carbon [EC]), and volatile organic compounds (VOCs). Full-shift personal noise monitoring was also conducted.

Concentrations of EC, a surrogate for diesel exhaust, ranged from 3.2 to 26 micrograms per cubic meter (µg/m³). There is no NIOSH evaluation criterion for EC; the California Department of Health Services recommends keeping levels below 20 µg/m³. PBZ concentrations of NO₂ and NO ranged from trace (defined as between 0.04 and 0.20 parts per million [ppm]) to 0.38 ppm. PBZ exposure for CO ranged from 1 to 8 ppm (full-shift Time-Weighted Average [TWA]) and from 1 to 19 ppm (15-minute short-term exposures). The dominant VOCs were isopropyl alcohol, toluene, and low molecular weight hydrocarbons. All were found at very low levels.

Noise levels for 4 of 16 employees monitored (3 in West baggage, 1 in Southeast baggage) exceeded the NIOSH REL for instituting a hearing conservation program. Other employees surveyed did not have excessive noise exposures that would increase their risk for occupational noise-induced hearing loss.

The NIOSH investigators determined that a hazard does not exist from exposure to EC, CO, CO₂, NO₂, NO, or VOCs. On average, none of the chemicals were detected at concentrations exceeding occupational exposure limits at the time of the NIOSH visit. Some tug emissions were elevated when compared to ambient levels and could contribute to an increase in air contaminants in some baggage areas. There was little evidence of a serious noise problem. Recommendations for maintaining the air quality and further reducing noise exposures are provided in the Recommendations Section of this report.

Keywords: 4581 (Airports, Flying Fields, and Terminal Services) diesel exhaust, nitrogen dioxide, nitric oxide, carbon monoxide, noise, airport, screeners, Transportation Security Administration, volatile organic compounds, respiratory, headache, dizziness.

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INTRODUCTION

On January 21, 2004, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Transportation Security Administration (TSA) to conduct a health hazard evaluation (HHE) at the Dulles International Airport (IAD) in Dulles, Virginia. The request specifically asked NIOSH to evaluate health hazards from exposure to contaminants found in the emissions of tug and jet engines and to evaluate the noise levels generated from tugs, jets, conveyor belts, and baggage carousels in the checked baggage screening area. The request indicated that some employees have experienced health problems possibly related to the work environment, including respiratory distress, dizziness, possible hearing loss, and headaches. In response to this request, NIOSH investigators conducted an initial site visit on March 30, 2004. On July 12-13, 2004, NIOSH returned to the site and conducted area and personal breathing zone (PBZ) air sampling for carbon monoxide (CO), nitrogen dioxide (NO₂), nitric oxide (NO), diesel exhaust (measured as elemental carbon [EC]), and volatile organic compounds (VOCs). Noise monitoring was also conducted.

BACKGROUND

IAD began operations in 1962. Built to accommodate up to six million passengers a year, IAD was one of the most modern airports in the world in 1962. As the number of passengers increased, the airport had to grow as well. The first expansion was completed in November 1977 with the widening of the jet parking ramp. In 1982, new passenger waiting areas were added to the upper level and a new baggage make-up area was added in the lower level. Midfield Concourses C and D, five cargo buildings, a hotel located on airport property, and economy parking lots were added through the 1980s. The Main Terminal was expanded in 1996. In 1998, the first permanent concourse was completed and a concourse for regional aircraft opened in 1999. Today, IAD serves more than 55,000 passengers a day and nearly 20 million passengers a year via 38 airlines.

On November 19, 2001, the Aviation and Transportation Security Act (ATSA) [49 CFR Parts 1500 et al.¹], which established TSA within the Department of Transportation, was signed into law. The law required TSA to hire and train federal security employees to inspect all passengers and property for explosives and incendiaries before boarding and loading onto the airplane. This rulemaking transferred the Federal Aviation Administration rules governing civil aviation security to TSA. A deadline of December 31, 2002, was established for airports and TSA to implement this law. The TSA employees at IAD began screening both passengers and baggage in December 2002.

Approximately 120 full- and part-time screeners are employed by TSA at IAD. Full-time employees work an 8-hour shift and part-time employees work a 4-hour shift. Checked passenger bags are screened in four geographically-different "Baggage Basements," East, West, Southeast and East Remote (MU-2). Bags checked by passengers at the ticketing counter are brought to the baggage area via conveyor belts. The conveyor belts deposit bags onto carousels where TSA employees manually load them onto a belt-driven conveyor that routes each bag through an Explosive Detection System (EDS) machine. Some bags undergo additional testing using an Explosive Trace Detection (ETD) system. After examination the bags are loaded back onto the carousel where airline personnel transfer the bags to carts attached to tugs for transport to the aircraft. On a daily basis, a large number of bags are handled and screened during "push" time periods when numerous flights from various airlines are scheduled to depart the airport within a narrow timeframe. It is during these times that tug traffic and the potential for exposure to combustion products are highest.

Three of the baggage basements contain four carousels and four L3 3DX™ 6000 EDS machines. The Remote baggage basement (MU-2) contains a single bag conveyor and two L3 machines. During the 2 days NIOSH conducted air sampling, IAD screened approximately 50,000 "checked" passenger bags. The baggage area was originally designed as a location for airline

employees to pick up and drop off checked passenger bags using ground service tugs. Large, pedestal-mounted fans were present at each L3 machine to increase air movement and provide comfort to workers in the bag screening area. General exhaust ventilation is provided in each of the baggage basements and is automatically controlled via CO sensors.

Each airline is responsible for maintaining and operating its own tugs. The fuel source powering the tugs varies by airline and includes diesel, gasoline, propane, and electric.

METHODS

Upon receipt of the HHE request, additional information regarding suspected environmental contaminants was obtained from the TSA Occupational Safety and Health manager and local TSA IAD management. During the initial site visit and subsequent telephone conversations with management and employees, an overview of the operation and layout of the four baggage basements was obtained and an environmental monitoring strategy was developed, as described below.

Diesel Exhaust (Elemental Carbon)

Full-shift PBZ samples for elemental carbon (EC), a surrogate for diesel exhaust particulate, were collected on 37-millimeter quartz fiber filters (closed face) using SKC® AirChek® 2000 sampling pumps. Thirteen screeners were monitored on July 12, 2004, and eleven screeners were monitored on July 13, 2004. Flow rates of approximately 2.5 liters per minute (Lpm) were used to obtain the samples. The sampling pumps were calibrated before and after each sampling event against a primary standard (BIOS® Dry-Cal) to verify flow rate. The filters were placed in the workers' breathing zone and connected via Tygon® tubing to the sampling pump. Screeners wore the sampling pump and filter for the entire work shift. After collection, the samples were sent to the NIOSH contract laboratory (DataChem, Salt Lake City, Utah) and analyzed in accordance with

NIOSH Method 5040.² With this technique, a representative punch-out of the filter is heated and analyzed with a thermal optical analyzer.

Nitrogen Dioxide (NO₂) and Nitric Oxide (NO)

Full-shift PBZ samples for NO₂ and NO were collected on sorbent tubes containing oxidizer plus a triethanolamine-treated molecular sieve in tandem using SKC® Pocket Pumps®. Five screeners were monitored on each of the 2 days of sampling. Four area samples were collected for NO₂ and NO on the first day of sampling followed by five area samples collected on the second day. Flow rates of approximately 0.050 Lpm and 0.20 Lpm were used to collect the PBZ and area samples, respectively. Each sampling pump was calibrated before and after each sampling event against a primary standard (BIOS® Dry Cal) to verify flow rate. The sorbent tubes were placed in the workers' breathing zone and connected via Tygon® tubing to the sampling pump. Screeners wore the sampling pump and filter for the entire work shift. After collection, the samples were sent to the NIOSH contract laboratory (DataChem, Salt Lake City, Utah) and analyzed in accordance with NIOSH Method 6014. Quantification was achieved via visible absorption spectrophotometry.²

In addition to sorbent tube sampling, NO₂ concentrations were measured using the Biosystems Toxilog Ultra®, a direct reading instrument equipped with electrochemical sensors that log average exposures, maximum 15-minute short-term exposures, and maximum peak exposures. These instruments were operated in a passive diffusion mode with a 30-second sampling interval. They were clipped to the belt of each worker for personal monitoring and worn for the entire work shift. Three screeners were monitored on each day of sampling. Stored data were downloaded to a laptop computer after sampling. Calibration of these monitors was accomplished before and after sampling according to the manufacturer's specifications.

Carbon Monoxide (CO)

Carbon monoxide exposures were evaluated using two types of instrumentation: the Biosystems Toxilog Ultra[®] and the Q-TRAK[®] Plus indoor air quality (IAQ) monitor model 8552/8554. The Toxilog Ultra[®] is a real-time, data-logging, passive CO monitor that logs average exposures, maximum 15-minute short-term exposures, and maximum peak exposures. These instruments were operated in a passive diffusion mode with a 30-second sampling interval. Nine personal samples were collected on July 12, 2004, and seven personal samples were collected on July 13, 2004. Personal samples were collected by attaching the instrument to the belt of each worker. All monitors operated for the entire work shift.

The Q-TRAK[®] device measures CO in real-time and these measurements were compared with those from the Toxilog Ultras. Instantaneous measurements of CO were taken throughout the baggage area during the work shift. Instrument calibration for both the Toxilog Ultras and the Q-TRAK was completed according to the manufacturers' recommendations.

Volatile Organic Compounds (VOCs)

Ambient air samples that screen for VOCs were collected on both days of sampling. The samples were collected on thermal desorption (TD) tubes attached by Tygon[®] tubing to SKC[®] Pocket Pumps[®] calibrated at a flow rate of 0.05 Lpm. The TD tubes, used for qualitative identification of VOCs, contain three beds of sorbent material: a front layer of Carbopack Y[™], a middle layer of Carbopack B[™], and a back section of Carboxen 1003[™]. The TD tubes were analyzed at the NIOSH laboratory with a Perkin-Elmer ATD 400 automatic thermal desorption system. The thermal unit was interfaced directly to an HP5890A gas chromatograph with an HP5970 mass selective detector according to NIOSH Method 2549.²

To analyze specific VOCs, (based on the results of the TD samples), full-shift ambient air samples were collected on charcoal tubes attached by Tygon[®] tubing to SKC[®] Pocket Pumps[®]

calibrated at a flow rate of 0.05 Lpm. Charcoal tube samples were collected simultaneously, in a side-by-side configuration, with the TD tubes. The charcoal tubes were sent to DataChem Laboratories, Inc. (Salt Lake City, Utah) to be quantitatively analyzed for hydrocarbons of interest (identified on the TD tubes) using a Hewlett-Packard model 5890A gas chromatograph equipped with a flame ionization detector according to NIOSH Methods 1300, 1400, 1501, and 1550 with modifications.²

Noise

TSA employees were selected to wear noise monitoring devices at the beginning of their work shift on each of the 2 days of sampling at IAD. NIOSH investigators randomly chose workers from the four baggage screening areas. The employees wore the meters for the entire work shift, through lunch and breaks. Area noise measurements were taken at both the luggage input side and output side of the EDS screening machines in the area where employees worked. Area noise measurements were also collected in the tunnel from the Southeast baggage basement area leading up to the tarmac. The analyzer was placed on a tripod with the microphone located at ear level for a standing employee in each of the tested areas.

Quest[®] Electronics Model Q-300 Noise Dosimeters were used to collect the daily noise exposure measurements from the employees volunteering to be in the NIOSH evaluation. The Quest dosimeters collect data so that one can directly compare the information with the three different noise criteria used in this survey, the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) and Action Level (AL), and the NIOSH Recommended Exposure Limit (REL). The dosimeter was secured on the workers' belts and the dosimeter's microphone attached to their shirt, halfway between the collar and the point of the shoulder. A windscreen provided by the manufacturer of the dosimeter was placed over the microphone during recordings. The noise information was downloaded to a personal computer for interpretation with QuestSuite[®] Professional computer software and the dosimeters

reset for the next day. The dosimeters were calibrated before and after the work shift according to the manufacturer's instructions.

The spectral area noise measurements were made with a Larson-Davis Laboratory Model 2800 Real-Time Analyzer and a Larson-Davis Laboratory Model 2559 ½" random incidence response microphone. The analyzer allows for the analysis of noise into its spectral components in a real-time mode. The ½"-diameter microphone has a frequency response range (± 2 decibels [dB]) from 4 Hertz (Hz) to 21 kilohertz (kHz) that allows for the analysis of sounds in the region of concern. One-third octave bands consisting of center frequencies from 25 Hz to 20 kHz were integrated for 30 seconds and stored in the analyzer for later analysis for the baggage screening areas. Because of the shorter nature of the noise exposure in the tunnel, the analyzer was set at a 10 second integration period for these measurements.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the criteria. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increases the overall exposure. Finally, evaluation

criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH RELs,³ (2) the American Conference of Governmental Industrial Hygienists (ACGIH®) Threshold Limit Values (TLVs®),⁴ and (3) the OSHA PELs.⁵ Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criteria.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91–596, sec. 5(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended STEL or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Diesel Exhaust (Elemental Carbon)

Diesel engines function by combusting liquid fuel without spark ignition. A mixture of air and fuel is introduced into the combustion chamber and ignition is accomplished by the heat of compression. The emissions from diesel engines consist of a complex mixture, including gaseous and particulate fractions. The composition of the mixture varies greatly with fuel and engine type, load cycle, maintenance, tuning, and exhaust gas treatment. The gaseous constituents include carbon dioxide, sulfur dioxide (SO₂), CO, NO, NO₂, and VOCs (e.g., ethylene, formaldehyde, methane, benzene, phenol, acrolein, and polynuclear

aromatic hydrocarbons).^{6,7,8,9} The particulate fraction (soot) is composed of solid carbon cores, produced during the combustion process, which tend to combine to form chains of particles or aggregates, the largest of which are in the respirable range (more than 95% are less than 1 micron in size).¹⁰ Estimates indicate that as many as 18,000 different substances resulting from the combustion process may be adsorbed onto these particulates.¹¹ The adsorbed material contains 15%–65% of the total particulate mass and includes compounds such as polynuclear aromatic hydrocarbons, a number of which are known mutagens and carcinogens.^{4,5,12,13}

Many of the individual components of diesel exhaust are known to have toxic effects. The following health effects have been associated with some of the components of diesel exhaust: (1) pulmonary irritation from oxides of nitrogen; (2) irritation of the eyes and mucous membranes from SO₂, phenol, sulfuric acid, sulfate aerosols, and acrolein; and (3) cancer in animals from polynuclear aromatic hydrocarbons. Several studies confirm an association between exposure to whole diesel exhaust and lung cancer in rats and mice.⁵ Limited epidemiological evidence suggests an association between occupational exposure to diesel exhaust emissions and lung cancer.¹⁴ The agreement of current toxicological and epidemiological evidence led NIOSH in 1988 to recommend that whole diesel exhaust be regarded as a “potential occupational carcinogen,” as defined in the OSHA’s Cancer Policy (“Identification, Classification, and Regulation of Potential Occupational Carcinogens,” 29 CFR 1990).⁵ Accordingly, NIOSH recommends that exposures be controlled to the lowest feasible concentration. Although OSHA and ACGIH have exposure limits for some of the individual components of diesel exhaust (i.e., NO₂, xylene, and CO), exposure limits have not been established for whole diesel exhaust. The California Department of Health Services Hazard Evaluation System & Information Service (HESIS) recommends exposures to diesel exhaust particles (measured as EC) be kept below 20 micrograms per cubic meter (µg/m³). This value was based on a risk assessment performed by the California Environmental Protection Agency’s

Office of Environmental Health Hazard Assessment that determined exposures to diesel particulate over a working lifetime of 20 µg/m³ would create an excess lung cancer risk of one in a thousand.¹⁵

Nitrogen Dioxide (NO₂)

Nitrogen dioxide gas is an irritant to the mucous membranes and its inhalation may cause severe coughing, which can be accompanied by mild or transient headache. The following health effects were observed in humans exposed to NO₂ for 60 minutes: at 100 parts per million (ppm), pulmonary edema and death; at 50 ppm, pulmonary edema, with possible subacute or chronic lesions in the lungs; and, at 25 ppm, respiratory irritation and chest pain.^{16,17} The effects of chronic low exposures are not well characterized in humans, but NO₂ would be expected to have an irritant effect upon the general mucosal surfaces and on the lower respiratory tract.¹⁶ Chronic exposures to 0.2 ppm with daily excursions to 0.8 ppm in mice were shown to cause decreased pulmonary function. This gas has not been shown to have teratogenic, mutagenic, or directly carcinogenic effects.¹⁷ The NIOSH REL for NO₂ is 1 ppm as a 15-minute STEL.³ The OSHA ceiling concentration is 5 ppm.⁵ The ACGIH TLV-TWA is 3 ppm and the TLV-STEL is 5 ppm.⁴

Nitric Oxide (NO)

Nitric oxide is a colorless gas that converts spontaneously in air to NO₂. The oxidation rate occurs more rapidly at higher NO concentrations.¹⁸ Therefore, it is difficult to identify the effects of NO exposures without considering the concomitant effects of NO₂. NO is a component of photochemical smog with ambient air concentrations reaching as high as 2.65 ppm.¹⁹ The most common occupational exposures to NO occur when it is formed as a by-product in the preparation of nitrosylcarbonyls and nitric acid, tobacco smoke, and from combustion of propane, diesel, and gasoline engines.¹⁶ In humans exposed to NO between 10 ppm and 40 ppm, significant lung vasodilation effects were observed.¹⁷ A comparative analysis of inhaled and exhaled breath in humans after exposure to NO at

concentrations of 5, 1, 0.5, and 0.33 ppm showed 85% to 93% retention in the body.¹⁸

Animal studies indicate that NO has an affinity for ferrous hemoglobin, which normally transports oxygen in the blood. The two substances react to form nitrosyl hemoglobin, a compound that is incapable of oxygen transport.¹⁸ This toxic action resembles that of CO. Exposures to mice to 5000 ppm for 6 to 8 minutes and to 2500 ppm for 12 minutes were lethal.¹⁷ Both NIOSH and OSHA have established a TWA exposure criterion of 25 ppm for NO.

Carbon Monoxide (CO)

Carbon monoxide is a colorless, odorless, tasteless gas produced by incomplete burning of carbon-containing materials such as gasoline or propane fuel. The initial symptoms of CO poisoning may include headache, dizziness, drowsiness, and nausea with symptoms advancing to vomiting, loss of consciousness, and collapse if prolonged or high exposures are encountered. If the exposure level is high, loss of consciousness may occur without other symptoms. Coma or death may occur if high exposures continue.^{4,17,20,21,22,23} The display of symptoms varies widely from individual to individual, and may occur sooner in susceptible individuals such as young or aged people, people with preexisting lung or heart disease, or those living at high altitudes.

The NIOSH REL for CO is 35 ppm for an 8-hour TWA exposure, with a ceiling limit of 200 ppm which should not be exceeded.^{18,20} The ACGIH recommends an 8-hour TWA TLV of 25 ppm.⁴ The OSHA PEL for CO is 50 ppm for an 8-hour TWA exposure.⁵ The immediately dangerous to life or health concentration (IDLH) is 1200 ppm. The IDLH exposure condition "poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment."²⁴

Volatile Organic Compounds (VOCs)

This is a large class of organic chemicals (i.e., containing carbon) that have a sufficiently high vapor pressure to allow some of the compound to exist in the gaseous state at room temperature. They are emitted in varying concentrations from numerous indoor sources including carpeting, fabrics, adhesives, resins, solvents, paints, cleaners, waxes, cigarettes, and combustion sources.

Noise

Noise-induced loss of hearing is an irreversible, sensorineural condition that progresses with exposure. Although hearing ability declines with age (presbycusis) in all populations, exposure to noise produces hearing loss greater than that resulting from the natural aging process. This noise-induced loss is caused by damage to nerve cells of the inner ear (cochlea) and, unlike some conductive hearing disorders, cannot be treated medically.²⁵ While loss of hearing may result from a single exposure to a very brief impulse noise or explosion, such traumatic losses are rare. In most cases, noise-induced hearing loss is insidious. Typically, it begins to develop at 4000 or 6000 Hz (the hearing range is 20 Hz to 20,000 Hz) and spreads to lower and higher frequencies. Often, material impairment has occurred before the condition is clearly recognized. Such impairment is usually severe enough to permanently affect a person's ability to hear and understand speech under everyday conditions. Although the primary frequencies of human speech range from 200 Hz to 2000 Hz, research has shown that the consonant sounds, which enable people to distinguish words such as "fish" from "fist," have still higher frequency components.²⁶

The A-weighted decibel [dBA] is the preferred unit for measuring sound levels to assess worker noise exposures. The dBA scale is weighted to approximate the sensory response of the human ear to sound frequencies near the threshold of hearing. The decibel unit is dimensionless, and represents the logarithmic relationship of the measured sound pressure level to an arbitrary

reference sound pressure (20 micropascals, the normal threshold of human hearing at a frequency of 1000 Hz). Decibel units are used because of the very large range of sound pressure levels which are audible to the human ear. Because the dBA scale is logarithmic, increases of 3 dBA, 10 dBA, and 20 dBA represent a doubling, tenfold increase, and hundredfold increase of sound energy, respectively. It should be noted that noise exposures expressed in decibels cannot be averaged by taking the simple arithmetic mean.

The OSHA standard for occupational exposure to noise (29 CFR 1910.95)²⁷ specifies a maximum PEL of 90 dBA for a duration of 8 hours per day. The regulation, in calculating the PEL, uses a 5 dB time/intensity trading relationship, or exchange rate. This means that a person may be exposed to noise levels of 95 dBA for no more than 4 hours, to 100 dBA for 2 hours, etc. Up to 16 hours exposure to 85 dBA is allowed by this exchange rate. The duration and sound level intensities can be combined in order to calculate a worker's daily noise dose according to the formula:

$$\text{Dose} = 100 \times (C_1/T_1 + C_2/T_2 + \dots + C_n/T_n),$$

where C_n indicates the total time of exposure at a specific noise level and T_n indicates the reference duration for that level as given in Table G-16a of the OSHA noise regulation. During any 24-hour period, a worker is allowed up to 100% of his daily noise dose. Doses greater than 100% are in excess of the OSHA PEL.

The OSHA regulation has an additional action level (AL) of 85 dBA; an employer shall administer a continuing, effective hearing conservation program when the 8-hour time-weighted average (TWA) value exceeds the AL. The program must include monitoring, employee notification, observation, audiometric testing, hearing protectors, training, and record keeping. All of these requirements are included in 29 CFR 1910.95, paragraphs (c) through (o). Finally, the OSHA noise standard states that when workers are exposed to noise levels in excess of the OSHA PEL of 90 dBA, feasible engineering or administrative controls shall be implemented to reduce the workers' exposure levels.

NIOSH, in its Criteria for a Recommended Standard,²⁸ and the ACGIH,⁴ propose exposure criteria of 85 dBA as a TWA for 8 hours, 5 dB less than the OSHA standard. These criteria also use a more conservative 3 dB time/intensity trading relationship in calculating exposure limits. Thus, a worker can be exposed to 85 dBA for 8 hours, but to no more than 88 dBA for 4 hours or 91 dBA for 2 hours. According to the NIOSH REL, 12-hour exposures must be 83 dBA or less.

RESULTS

Air Sampling Results

The results of the air sampling for diesel exhaust (EC) are shown in Table 1. A total of 24 samples were collected in different baggage basements (East, West, Southeast and East Remote (MU-2)) over the 2-day sampling period. Average concentrations of EC ranged from 9.8 $\mu\text{g}/\text{m}^3$ for West Baggage to 18 $\mu\text{g}/\text{m}^3$ for East Baggage. The overall average for all airport baggage screening areas was 14 $\mu\text{g}/\text{m}^3$. The minimum detectable concentration (MDC) of 0.5 $\mu\text{g}/\text{m}^3$ was calculated using the analytical LOD for EC and an average sample volume of 1080 liters of air.

The results of the air sampling for NO and NO₂ appear in Table 2. A total of 10 PBZ samples were collected. Average values for PBZ NO samples ranged from 0.05 ppm to 0.38 ppm. Average values for NO₂ ranged from 0.09 ppm to 0.11 ppm. Of the four baggage basements evaluated, the highest NO measurement obtained from all PBZ samples occurred in the Southeast baggage basement (0.38 ppm). The MDC for PBZ samples for NO was calculated to be 0.04 ppm assuming an average sample volume of 20 liters of air. The MDC for PBZ samples for NO₂ was calculated to be 0.03 ppm assuming an average sample volume of 20 liters of air.

A total of 9 ambient air samples for NO and NO₂ were collected in the center of various screening areas. Values for NO ranged from 0.07 to 0.33 ppm. Values for NO₂ ranged from 0.04 to 0.12 ppm. The MDC for ambient air samples for NO and NO₂ was calculated to be 0.01 ppm assuming an average sample volume of 78 liters of air.

NO₂ exposure data collected using the Toxilog Ultra device appear in Table 3. Full-shift TWA and short-term exposures to NO₂ measured with the Toxilog Ultra device were all non-detectable. Instantaneous peak concentrations ranged from 0.1 ppm to 1 ppm.

Personal full-shift TWA exposures to CO ranged from 1 ppm to 8 ppm; 15-minute short-term exposures ranged from 1 ppm to 19 ppm. The results from the Toxilog Ultra sampling for CO are shown in Table 4. Instantaneous peak exposures ranged from 6 ppm to 176 ppm. The afternoon shift working in the Southeast baggage basement exhibited the highest full shift TWA exposures (7–8 ppm) while workers on the morning shift in the East baggage basement had the lowest (1–2 ppm).

Instantaneous ambient air carbon dioxide, CO, temperature, and relative humidity measurements were collected using the Q-TRAK[®] direct-reading instrument in various screening areas within each baggage basement during both days of sampling. A summary of all measurements, grouped by baggage basement, appears in Table 5.

The dominant VOCs qualitatively identified on the TD tubes and subsequently analyzed quantitatively via charcoal tubes included isopropanol, toluene, and total low molecular weight hydrocarbons. Values for isopropanol ranged from “none detected” (ND) to 0.76 mg/m³. Values for toluene ranged from Trace to 0.17 mg/m³. Values for total low molecular weight hydrocarbons ranged from ND to 1.1 mg/m³. A summary of the data collected for these compounds appears in Table 6.

Tug Emissions

A random spot check of tailpipe emissions from gasoline-powered tugs operating in two different baggage basements (West and Southeast) was performed using a GasLink LT[™] Emissions analyzer (Ferret Instruments, Cheboygan, Michigan). This instrument is capable of measuring hydrocarbons (HC), CO, CO₂, and oxides of nitrogen (NO_x) in real time.

As gasoline-powered tugs operated in the traffic lanes of the baggage basements, drivers were asked to stop momentarily while emissions from

the idling tug were measured at the tailpipe and recorded. Values for hydrocarbons ranged from 77 ppm to 1600 ppm. CO values ranged from 0.04% to 8.7% while NO_x values ranged from 0 ppm to 7 ppm. The ambient levels of HC, CO, and NO_x were 3 ppm, 0%, and 0 ppm, respectively for the West Baggage Basement. The ambient levels of HC, CO, and NO_x for the Southeast Baggage basement were 5 ppm, 0%, and 0 ppm, respectively. The majority of the tugs tended to run roughly and have an unstable idle. One particular tug operating in the West baggage basement emitted heavy black soot that deposited on the analyzer’s probe. This tug also emitted a strong odor while simultaneously irritating the eyes, nose and throat of the emission analyzer operator. Diesel-powered tug emissions were not evaluated during this survey because the instrument can only operate accurately with a single sensor designed to detect emissions from a specific type of engine (i.e. gasoline only, diesel only, etc.) Sensors specific to diesel engines were not used because they must be installed and calibrated by the manufacturer. Data collected during the gasoline-powered tug spot measurements appear in Table 7.

Noise

Eight TSA screeners wore noise dosimeters on each survey day for their work shift. The screeners were generally assigned to one screening machine, although a few employees worked in two areas during their shift. The noise exposure results for each individual are shown in Table 8 and are compared to the three different noise criteria used in this survey; the OSHA PEL and AL, and the NIOSH REL. The OSHA criteria use a 90 dBA criterion and 5-dB exchange rate for the PEL and AL. The difference between the two is the threshold level employed, with a 90 dBA threshold for the PEL and an 80 dBA threshold for the AL. The threshold level is the lower limit of noise values included in the calculation of the criteria; values less than the threshold are ignored by the dosimeter. The NIOSH criterion differs from OSHA in that the criterion is 85 dBA, the threshold is 80 dBA, and it uses a 3-dB exchange rate. The devices calculate the percent daily dose for the time that the meter was accumulating data as well as an extrapolated value for an 8-hr work

shift. The data in the table are reported as the percent daily dose for each noise criteria as an 8-hr TWA.

Of the 16 surveyed employees who worked in the Southeast baggage basement, one was found to have a daily dose that exceeded the OSHA AL (52.3%). When the dosimeter data were compared to the NIOSH REL, 4 of 16 employees exceeded the criterion. Three worked in the West baggage basement area and the fourth was the same Southeast baggage basement area screener that exceeded the OSHA AL. The dosimeter readouts for these TSA screeners are presented in Figures 1-4. The noise exposure patterns revealed in the figures are similar in the West baggage basement area, but these are different than the pattern seen in the Southeast baggage basement area. The screeners in the West baggage basement all had several 1-minute periods greater than 95 dBA but the rest of the noise exposures are generally less than 85 dBA. Conversely, the TSA screener working in the Southeast baggage basement spends a considerable portion of the time in noise greater than 85 dBA.

The area noise samples were collected to document specific noises in the baggage screening areas. In the West baggage basement area, the carousel serving areas WB-1 and WB-2 had a noticeable, high-pitched squeaky sound. The area measurement revealed a predominant sound at the third-octave band center frequency of 8.0 kHz (Figure 5). This high-pitched squeak seemed to periodically change in intensity when listening from a stationary place in the West baggage basement, getting loud when a particular section of the carousel was near the listener and fading as the section moved away. Inspection of the conveyor found wheels on the underside of the metal conveyor that rolled along a track when the carousel was in motion. It is believed that one or more of the wheels caused the high-pitched noise in the baggage area.

In the East baggage Remote (MU-2) screening area, employees expressed concern about the intensity of the alarms that sounded whenever bags reached the end of the conveyor belt. One of the alarms was located on the back wall adjacent

to the ER-2 L3 screening machine. Area noise measurements were made while the alarm was sounding and when the alarm was off. These two events are depicted in Figure 6. The one-third octave bands are similar for the two alarm conditions with the exceptions of 2.5 kHz and 3.15 kHz. The alarm adds 13 dB and 8 dB, respectively at these two third-octave bands.

The last location where area noise measurements were taken was in the tunnel running from the Southeast baggage basement up to the tarmac. The tunnel is constructed as a snake-like roadway. The real-time analyzer and tripod were located on a curve in the road where drivers of the tugs would not be able to see the investigators until they were very close. The time of integration was reduced to 10 seconds because of the transient nature of the noise produced as the tugs and baggage carts passed by. A total of seven measurements ranging from 84 to 104 dBA were collected while tugs and carts traveled through the tunnel. Because the drivers thought the noise analyzer was a speed trap, they suddenly slowed the tugs, thus lowering the noise they emitted. Therefore, only a limited number of samples was collected.

Workplace Information

Environmental control of the four baggage basements relies mainly on general dilution ventilation systems remotely controlled by a computerized CO sensor system. These systems utilize 100% outside make-up air to ventilate the baggage basements. The East Baggage Basement ventilation system consisted of intake vents mounted flush in the floor, covered with grating, and connected to duct work routed to an outside wall for discharge. We observed many of the intake grates obscured with debris, thereby reducing the efficiency and effectiveness of this particular ventilation system. The remaining three baggage basements utilized a series of ducts with numerous discharge ports (vents) positioned along their length.

According to design, as CO levels rise, fans connected to a series of ducts begin to run at increasing speeds until the CO levels attain a concentration of 15 ppm, at which time the fans run at 100% of their maximum volumetric flow

rate (approximately 27,000 cubic feet per minute [CFM]). This fan/duct configuration is designed to keep the baggage basements under negative pressure when the system is operating. CO sensors located in the baggage basements are periodically checked and calibrated for accuracy and operation by airport maintenance staff using a direct-reading CO monitor.

Across airlines, a variety of tugs and fuels are used (gasoline, diesel, propane, electric). Despite a request from TSA to the airlines for tug maintenance schedules and records, no information was provided. We also observed that tugs are frequently left idling near TSA screeners while airline employees load and unload bags. Employees reported on the days of our survey that airline employees were more likely than usual to turn off tugs. Employees also reported that during cold weather, some tugs are started inside the baggage basements and allowed to run for extended periods of time while warming up.

In general, housekeeping in the baggage basements was poor. Some areas were cluttered with items that not only created a trip hazard, but often partially obscured the floor-mounted intake vents (East Baggage basement). Cracks in floors and uneven walking surfaces also created a trip hazard for employees. In addition, empty metal baggage carts pulled by tugs often passed over cracks in the concrete floor resulting in “cart bounce”, which created unnecessary noise.

NIOSH investigators noticed that some of the L3 cooling condensate discharge lines were draining into the floor-mounted intake vents. This practice could create an environment conducive to mold/fungi growth and possibly contribute to large-scale contamination of the entire ventilation system.

Isopropanol is the only chemical used by TSA employees to periodically clean the table tops where manual bag inspection and ETD processing occurs. Vinyl gloves are available to all employees, and those who conducted internal bag inspections used them. No formal written hearing protection program is currently in place at the airport and very few TSA employees were

observed wearing hearing protection devices (HPDs).

DISCUSSION

Air Contaminants

A total of 24 EC samples were collected from the PBZs of workers on two different shifts over 2 days (Table 1). The airport-wide average for EC was $14 \mu\text{g}/\text{m}^3$. Individual PBZ concentrations of EC ranged from $3.2 \mu\text{g}/\text{m}^3$ to $26 \mu\text{g}/\text{m}^3$. The highest exposures (25 and $26 \mu\text{g}/\text{m}^3$) exceeded the California Department of Health Services (CDHS) Hazard Evaluation System and Information Service (HESIS) recommendation of $20 \mu\text{g}/\text{m}^3$. These employees worked in the East baggage basement at EDS machines 1 and 2 on Tuesday afternoon (July 13). The next highest EC exposure ($22 \mu\text{g}/\text{m}^3$) was measured on the employee working at Machine SE-1 in the Southeast baggage basement on Tuesday afternoon (July 13). In comparing the average EC values across different baggage basements, East baggage was the highest and West baggage was the lowest. These average values were consistent, with a relatively narrow range of $10 - 18 \mu\text{g}/\text{m}^3$. Based on the experience of the NIOSH investigators and compared to other NIOSH diesel exhaust studies¹⁰, these measured EC levels are not unusually high. The variation in exposures to diesel exhaust is likely due to the presence or absence of diesel-powered tugs in the area as well as the efficiency and effectiveness of the ventilation systems within each baggage basement. Also, airlines own and operate their own tugs and the fuel source varies; therefore, employee exposures may vary depending on their work location.

A total of 10 PBZ samples each for NO_2 and NO were collected on two different shifts over 2 days (Table 2). PBZ concentrations measured for NO_2 and NO were found to range from Trace to 0.38 ppm. These results are in agreement with the NO_2 results from the real time Toxilog Ultra[®] monitors; full-shift and 15-minute short-term exposures were all very low to non-detectable (Table 3). The single Southeast baggage basement PBZ sample had the highest concentration measured for NO (0.38 ppm). This measurement, however, is

approximately 66 times less than the ACGIH 8-hour TLV. All measurements for NO₂ were found to be Trace. Ambient air samples for NO₂ and NO exhibited the same concentration patterns as those observed with the PBZ samples. All values were very low. However, once again, the Southeast baggage basement had the highest reading for NO (0.33 ppm).

A total of 16 full-shift samples for CO were collected from workers in three of the busier baggage basements (East, West, and Southeast) across 2 days. Eight-hour TWA exposures ranged from 1 ppm to 8 ppm. A clear trend was observed with CO exposures across the different baggage basements. Once again, the Southeast baggage basement had higher 8-hour TWA exposure values than either East or West baggage basements. In fact, the average TWA value for CO in the Southeast baggage basement was approximately seven times higher than the majority of TWAs recorded in the East baggage basement (Table 4). Peak values ranged from 6 ppm to 176 ppm. Both of these values were measured in the East baggage basement. None of the measurements exceeded the OSHA ceiling limit of 200 ppm or approached the IDLH value of 1200 ppm. None of the 15 minute STEL measurements exceeded 19 ppm.

Instantaneous ambient air CO concentrations obtained in the different baggage basement areas were in agreement with the Toxilog Ultra[®] instruments. An interesting trend emerged when comparing CO concentrations observed in the morning versus afternoon shifts within the same baggage basement (East). On average, CO concentrations were found to be 3.5 times higher in the afternoon than in the morning and may be attributed to increased tug traffic. Once again, the highest average reading for all baggage basements studied was observed in the Southeast Baggage basement (Table 5).

Throughout the course of this study, environmental variables such as temperature, relative humidity, and CO₂ remained fairly constant. However, the Southeast baggage basement was slightly warmer and less humid than the other areas evaluated. This trend is evident based on the data presented in Table 5.

Tug exhaust emissions were considered the primary source of CO in the bag screening area. However, NIOSH cannot rule out the possibility of a worker taking a break outside the baggage screening area and receiving exposure from other sources such as automobiles, buses, or exhaled cigarette smoke.

Thermal desorption sampling for a variety of VOCs did not identify any unusual compounds. Full-shift area samples for isopropanol, toluene, and low molecular weight hydrocarbons were well below any occupational exposure limits (Table 6).

Although data from air sampling do not show an inhalational hazard in the baggage screening area, the potential exists for increased exposure to tug exhaust emissions if the tugs are not properly maintained or if properly maintained tugs do not procedurally operate under the same conditions of those in the area on the day of the NIOSH survey (e.g., shut off tugs while loading/unloading). TSA management is currently working with the airlines on following manufacturer-recommended maintenance procedures for the tugs. Recently, airline employees have been instructed to turn off the tug engines when loading/unloading baggage and to follow all speed limit and driving rules in the area. TSA employees reported that airline employees often leave the tugs idling while loading/unloading bags or when exiting the tug for short durations. Leaving the engine running unnecessarily contributes to increased concentrations of airborne contaminants. Clearly, emissions can rise to very high levels (especially hydrocarbons and CO) if tugs are not maintained in good running condition (Table 7).

Ventilation

Each baggage basement area is mostly enclosed, with an opening to the outside environment via a single doorway. Depending on the outdoor environmental conditions, each baggage basement can be naturally ventilated by strong winds. Alternatively, calm winds and certain directional wind flows do not provide natural ventilation to the area. Mechanical ventilation systems are present in each of the baggage basements. These systems, which operate on demand when CO levels reach a specific set-point, could be used to

control the concentrations of CO more effectively by adjusting the set-point lower. This would, in effect, cause the ventilation system to activate sooner (while CO levels are lower) and run longer to provide better control of airborne contaminants. The large pedestal-type fans in each screening pod areas appeared to provide some cooling relief to the workers when the ambient temperature and humidity increased. However, the effectiveness of the pedestal-type fans in providing control of airborne contaminants was not evaluated in this study. The issue of routing drain lines from the L3 machines to floor intake vents needs to be addressed by airport maintenance staff. By depositing water into the ventilation system, the probability of creating an environment conducive to mold and fungus growth remains high.

Noise

The daily noise exposures measured in the survey were generally less than the evaluation criteria. The few noise doses that exceeded the NIOSH REL appeared to be the result of short-term, random events. These could be the result of impacts between objects, e.g., dropping a hard container onto the concrete floor, or from loud shouts near the microphone worn by the employee. There was no consistent pattern in these short-term events seen in the West baggage basement screening area which implies that these were very localized events that did not affect the entire area. However, the more consistent higher noise levels measured for the employee working in the Southeast baggage basement should be confirmed with an additional noise survey. This employee's noise level exceeded the NIOSH REL as well as the OSHA action level for instituting a hearing conservation program. This area was in a corner next to aisles affected by tug traffic from both the airline(s) whose baggage was screened at the SE-1 location and from other airlines' tugs driving past to reach their carousels at SE-2, SE-3, and SE-4. The employees surveyed in the East baggage basement and East baggage Remote (MU-2) baggage screening areas did not appear to have excessive noise exposures that would increase their risk for occupational noise-induced hearing loss.

The noise survey identified two situations that warrant the attention of the airport authority

responsible for maintaining the facilities. The carousel in the West baggage basement screening area between WB-1 and WB-2 needs to be inspected to determine the source of the audible squeaking noise. A cursory visual inspection seemed to point to one or more of the wheels on the underside of the conveyor that traveled along the track underneath the conveyor. Even though the squeaky noise is not loud enough to be hazardous to the employees' hearing, it certainly is an annoyance that could be easily eliminated. The other identified noise was the alarm in the East baggage Remote (MU-2) baggage screening area. Several TSA employees expressed annoyance that the alarm often sounded for minutes at a time with little attention from employees who could do something to stop the alarm, i.e., remove the luggage from the end of the conveyor. The alarm's speaker was covered with tape to reduce the noise it emitted. This is a similar situation to the one in the West baggage basement area where the offending noise is not hazardous to hearing but is annoying. Employees found the alarm particularly annoying because it fails to affect employee behavior, i.e., causing someone to remove the luggage.

CONCLUSIONS

An inhalational hazard from tug exhaust emissions did not exist at the time of the NIOSH visit. Concentrations of these air contaminants may vary due to a number of factors. For example, dilution ventilation achieved via fans and ductwork, as well as the presence of pedestal-type fans can affect the air quality. The overall performance of the ventilation system used in the East Baggage Basement was lowered due to debris obscuring the floor-mounted intake vents. Contaminant exposures could increase if tugs are not properly maintained, sit in idle mode for extended periods of time, or if tug traffic increases. Weather conditions may also affect contaminant concentrations. Thus, even though the contaminant levels were below relevant occupational exposure limits at the time of this survey, it is important to continue to work with the airlines to ensure that tugs are maintained according to standard operating procedures (e.g., routine engine tune-ups, oil and oil filter changes).

Good communication and cooperation with the airlines will help to ensure this.

Generally, the noise exposures to which TSA employees are subjected during their work activities do not pose a risk for occupational noise-induced hearing loss. The one area that needs additional documentation is the Southeast baggage basement screening area. The testing should be conducted during days of maximum tug activity. In the other baggage screening areas where annoying noises were identified, management should address the sources of the noise and attempt to eliminate it, in the case of the squeaky carousel, or change it so that it truly identifies a situation that needs immediate attention, in the case of the alarm.

Some TSA employees were curious about the type of HPDs that might be worn in their work area. As stated earlier, most of the surveyed baggage screening areas were not sufficiently loud enough to warrant the use of HPDs to protect workers' hearing from occupational noise. Because of vehicle traffic in the baggage screening areas and the need to communicate with other employees, there is the chance that some HPDs would actually over-protect workers and lead to a loss of important auditory signals that workers need to perform their jobs. If workers choose to wear HPDs while working, TSA should educate their employees about the flat spectrum, moderate attenuation devices, sometimes referred to as "musician earplugs," available on the market. However, TSA management should also stress that the noise environments are not loud enough to necessitate the use of HPDs to reduce the risk of occupational noise-induced hearing loss in their employees. A mechanism is needed for employees to report perceived increases in noise levels in their work areas. Noise surveys should be conducted based on these results.

RECOMMENDATIONS

1. Reduce or eliminate the annoying sounds identified in this evaluation (squeaky conveyor, loud alarm). A maintenance plan should be written for the conveyors and carousels to eliminate squeaks and rattles as soon as they are

identified. Auditory alarms should be used in situations where they immediately initiate an action that turns the alarm off.

2. Perform additional employee noise exposure measurements in the Southeast baggage basement screening area. If the OSHA AL is consistently exceeded, then TSA management needs to implement a hearing conservation program that meets the OSHA requirements for employees working in this area.²⁷

3. Develop a procedure for employees to report changes in their work environment to TSA management. The report should trigger an appropriate response to the perceived hazard. These results should then be communicated back to the affected employees in a timely manner.

4. Improve housekeeping in all areas, especially in the East Baggage Basement, to prevent buildup and subsequent blockage of the intake vents. Blocked or obscured intake vents diminish the overall efficiency and effectiveness of the entire ventilation system.

5. Redirect the L3 machine cooling condensate lines so they do not drain into the floor-mounted intake vents. This practice encourages mold/fungi growth that could contaminate the entire ventilation system.

6. Improve the tug maintenance policy and procedures (i.e., regularly scheduled tune-ups, filter changes, etc.) TSA and airline management should work together toward the common goal of improving air quality in the baggage basements by ensuring that tugs are maintained and operated according to standard operating procedures.

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Table 1
TSA - Washington-Dulles International Airport
Personal Breathing Zone Diesel Exhaust (Elemental Carbon) Results ($\mu\text{g}/\text{m}^3$)
HETA 2004-0100-2946
Dulles, Virginia
July 12-13, 2004

Location	Number of Samples	Mean	Std. Dev.	Minimum	Maximum
East Baggage	9	18	4.7	14	26
West Baggage	8	9.8	2.9	6.3	15
Southeast Baggage	6	15	6.6	3.2	22
Remote Baggage (MU-2)	1	16	N/A	N/A	N/A
Airport-Wide (All Samples)	24	14	5.6	3.2	26

MDC = $0.48 \mu\text{g}/\text{m}^3$

MQC = $1.58 \mu\text{g}/\text{m}^3$

N/A = Not applicable

$\mu\text{g}/\text{m}^3$ = micrograms per cubic meter

MDC = minimum detectable concentration

MQC = minimum quantifiable concentration

Table 2
TSA - Washington-Dulles International Airport
Personal Breathing Zone (PBZ) and Ambient Air
Nitric Oxide (NO) and Nitrogen Dioxide (NO₂) Results
HETA 2004-0100-2946
Dulles, Virginia
July 12-13, 2004
PBZ Samples by Location

Nitric Oxide (ppm)						Nitrogen Dioxide (ppm)				
Location	Number of Samples	Mean	Std. Dev.	Minimum	Maximum	Number of Samples	Mean	Std. Dev.	Minimum	Maximum
East Baggage	6	0.18 (Trace)	0.02	0.15	0.2	6	0.09 (Trace)	0.02	0.07	0.13
West Baggage	2	0.05 (Trace)	0.03	0.03	0.08	2	0.11 (Trace)	0.01	0.10	0.11
Southeast Baggage	1	0.38	N/A	N/A	N/A	1	0.10 (Trace)	N/A	N/A	N/A
East Baggage Remote (MU-2)	1	0.12 (Trace)	N/A	N/A	N/A	1	0.10 (Trace)	N/A	N/A	N/A
MDC = 0.04 ppm MQC = 0.20 ppm ppm = parts per million						MDC = 0.03 ppm MQC = 0.13 ppm ppm = parts per million				

Ambient Air Samples by Location

Nitric Oxide (ppm)						Nitrogen Dioxide (ppm)				
Location	Number of Samples	Mean	Std. Dev.	Minimum	Maximum	Number of Samples	Mean	Std. Dev.	Minimum	Maximum
East Baggage	3	0.14	0.03	0.11	0.17	3	0.12	0.02	0.11	0.14
West Baggage	3	0.07	0.00	0.07	0.08	3	0.04	0.01	0.03	0.04
Southeast Baggage	3	0.33	0.04	0.30	0.38	3	0.10	0.01	0.09	0.11
East Baggage Remote (MU-2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MDC = 0.01 ppm MQC = 0.05 ppm ppm = parts per million						MDC = 0.01 ppm MQC = 0.03 ppm ppm = parts per million				

Table 3
TSA - Washington-Dulles International Airport
Nitrogen Dioxide (NO₂) Toxilog Ultra[®] Results (ppm)
HETA 2004-0100-2946
Dulles, Virginia
July 12-13, 2004

Personal Breathing Zone Samples by Location

Date	Time On	Time Off	Location	TWA	STEL	Peak
7/12/2004	4:36 a.m.	12:30 p.m.	West Baggage - Pod #1	0.0	0.0	0.2
7/12/2004	4:37 a.m.	12:35 p.m.	West Baggage - Pod #3	0.0	0.0	0.4
7/12/2004	4:47 a.m.	12:47 p.m.	East Baggage - Pod #1	0.0	0.0	0.8
7/13/2004	12:52 p.m.	8:40 p.m.	Southeast Baggage - Pod #4	0.0	0.0	0.4
7/13/2004	1:29 p.m.	8:33 p.m.	East Baggage - Pod #2	0.1	0.1	1.0
7/13/2004	1:03 p.m.	8:56 p.m.	East Baggage - Pod #1	0.0	0.1	1.0

ppm = parts per million.

TWA = Time-Weighted Average = average airborne concentration of a substance during a normal 8- to 10-hour workday

STEL = Short-term exposure limit = 15-minute TWA exposure

Peak = Highest measured concentration during the work day

Table 4
TSA - Washington-Dulles International Airport
Carbon Monoxide (CO) Toxilog Ultra[®] Results (ppm)
HETA 2004-0100-2946
Dulles, Virginia
July 12-13, 2004

Personal Breathing Zone Samples by Location

Date	Time On	Time Off	Location	TWA	STEL	Peak
7/12/2004	5:15 a.m.	12:38 p.m.	East Baggage - Pod #3	1	2	9
7/12/2004	5:21 a.m.	12:47 p.m.	East Baggage - Pod #1	1	2	17
7/12/2004	4:51 a.m.	12:34 p.m.	East Baggage - Pod #1	1	0	6
7/12/2004	5:02 a.m.	12:29 p.m.	East Baggage - Pod #2	1	4	21
7/12/2004	4:42 a.m.	12:37 p.m.	East Baggage - Pod #4	2	12	40
7/13/2004	1:01 p.m.	8:55 p.m.	East Baggage - Pod #1	3	2	32
7/13/2004	12:55 p.m.	8:54 p.m.	East Baggage - Pod #3	3	1	176
7/13/2004	1:12 p.m.	8:54 p.m.	East Baggage - Pod #2	1	1	7
7/12/2004	4:44 a.m.	12:38 p.m.	West Baggage - Pod #3	3	4	21
7/12/2004	4:51 a.m.	12:29 p.m.	West Baggage - Pod #2	2	3	14
7/12/2004	4:47 a.m.	12:27 p.m.	West Baggage - Pod #1	4	19	89
7/12/2004	4:44 a.m.	12:38 p.m.	West Baggage - Pod #3	3	4	21
7/13/2004	12:53 p.m.	9:00 p.m.	Southeast Baggage - Pod #4	7	7	37
7/13/2004	1:03 p.m.	8:50 p.m.	Southeast Baggage - Pod #1	7	7	24
7/13/2004	1:14 p.m.	8:49 p.m.	Southeast Baggage - Pod #3	7	7	38
7/13/2004	1:05 p.m.	8:26 p.m.	Southeast Baggage - Pod #2	8	5	38

ppm = parts per million

TWA = Time-Weighted Average = average airborne concentration of a substance during a normal 8- to 10-hour workday

STEL = Short-term exposure limit= 15-minute TWA exposure

Peak = Highest measured concentrations during the work day

Table 5
TSA - Washington-Dulles International Airport
Environmental Conditions
HETA 2004-0100-2946
Dulles, Virginia
July 12-13, 2004

East Baggage Area – Morning Shift (7/12/2004)

	CO₂ (ppm)	CO (ppm)	Temp (F)	Rel. Hum. (%)
Mean	694	0.9	82.7	63.0
Standard Deviation	48.6	0.2	0.4	2.1
Minimum	638	0.4	82.4	61.5
Maximum	725	1.1	82.9	64.5
No. of Measurements	3	12	2	2

West Baggage Area – Morning Shift (7/12/2004)

	CO₂ (ppm)	CO (ppm)	Temp (F)	Rel. Hum. (%)
Mean	444	5.3	81.3	72.8
Standard Deviation	19.1	0.6	0.4	1.4
Minimum	419	4.0	80.6	70.0
Maximum	470	6.2	82.0	75.0
No. of Measurements	12	12	12	12

East Baggage Area – Afternoon Shift (7/13/2004)

	CO₂ (ppm)	CO (ppm)	Temp (F)	Rel. Hum. (%)
Mean	437	3.5	85.6	57.2
Standard Deviation	20.4	1.8	1.8	3.7
Minimum	412	2.0	81.3	52.4
Maximum	476	7.1	87.6	63.0
No. of Measurements	9	9	9	9

Southeast Baggage Area – Afternoon Shift (7/13/2004)

	CO₂ (ppm)	CO (ppm)	Temp (F)	Rel. Hum. (%)
Mean	513	8.6	89.9	46.0
Standard Deviation	34.6	1.6	0.4	2.6
Minimum	458	5.1	89.3	42.6
Maximum	566	10.2	90.5	49.8
No. of Measurements	11	11	11	11

ppm = Parts per million

Temp (F) = Temperature in Degrees Fahrenheit

Rel. Hum. (%) = Relative Humidity in Percent

Table 6
TSA - Washington-Dulles International Airport
Volatile Organic Compounds – Ambient Air Samples (mg/m³)
HETA 2004-0100-2946
Dulles, Virginia
July 12-13, 2004

Ambient Air Area Samples (Activated Charcoal Tubes)

Date	Location	Sampling Duration (min)	Isopropanol	Toluene	Total Low Hydrocarbons
7/12/2004	West Baggage-4	431	0.33 (Trace)	0.09	0.33 (Trace)
7/12/2004	West Baggage-2	437	0.28 (Trace)	0.11	0.37 (Trace)
7/12/2004	East Baggage-1	446	ND	0.05	ND
7/13/2004	Southeast Baggage-3	396	ND	0.07	ND
7/13/2004	Southeast Baggage-1	369	0.76	0.17	1.09
7/13/2004	East Baggage-1	426	0.19 (Trace)	0.042 (Trace)	ND

MDC = 0.19 mg/m³
MQC = 0.48 mg/m³

MDC = 0.019 mg/m³
MQC = 0.048 mg/m³

MDC = 0.14 mg/m³
MQC = 0.48 mg/m³

Average sample volume = 20.76 L or 0.021 m³
(mg/m³) = Air Concentration in units of milligrams per cubic meter of air
ND = None Detected; Value was below the MDC
Trace = Value was below the MQC, but above the MDC

Table 7
TSA - Washington-Dulles International Airport
Gasoline-Powered Tug Emissions
HETA 2004-0100-2946
Dulles, Virginia
July 12-13, 2004

Date	Time	Tug ID	Location	HC (ppm)	CO (%)	NO _x (ppm)	Comments
7/12/2004	9:03 a.m.	None	West Baggage	3	0.0	0.0	Ambient air level, no tugs nearby
7/12/2004	9:25 a.m.	19859 AA	West Baggage	1600	8.7	0.0	Heavy black soot deposit on probe, engine runs poorly, strong odor and burning sensation in nose, throat and eyes
7/12/2004	9:35 a.m.	14343 NW	West Baggage	77	2.0	3.0	Engine runs smoother than previous tug, # 19859 AA
7/12/2004	10:00 a.m.	80306 AA	West Baggage	570	0.62	1.0	
7/12/2004	10:07 a.m.	380 Swiss	West Baggage	20	0.11	9.0	
7/13/2004	4:15 p.m.	None	Southeast Baggage	5	0.0	0.0	Ambient air level, no tugs nearby
7/13/2004	4:55 p.m.	DHTD57	Southeast Baggage	442	0.09	7.0	Engine has audible "miss", erratic idle
7/13/2004	4:57 p.m.	DHTD12	Southeast Baggage	640	0.05	0.0	Engine has audible "miss", erratic idle
7/13/2004	5:00 p.m.	DH155	Southeast Baggage	1700	0.04	0.0	Engine runs poorly, erratic idle, strong odor, burning sensation in nose, throat, and eyes.
7/13/2004	5:04 p.m.	DHTD59	Southeast Baggage	645	0.68	0.0	Smooth idle

HC = Hydrocarbons
CO = Carbon Monoxide
NO_x = Oxides of Nitrogen

Table 8
Personal Noise Dosimeter Data
TSA -Washington Dulles International Airport
HETA 2004-0100-2946
Dulles, Virginia
July 12-13, 2004

Worker Location	Sample Time hh:mm	8-hr PEL % Dose	8-hr AL % Dose	8-hr REL % Dose
July 12, 2004				
WB-4: Screener #1	07:47	6.5	22.2	69.9
WB-4: Screener #2	07:51	1.9	8.1	39.5
WB-3: Screener #1	07:45	0.2	3.5	19.3
WB-3: Screener #2	07:36	21.4	33.3	1186.9
WB-2: Screener #1	07:37	5.0	10.2	159.1
WB-2: Screener #2	07:44	5.3	12.1	73.9
WB-1: Screener #1	07:51	5.9	21.0	75.1
WB-1: Screener #2	07:50	9.8	27.6	108.0
July 13, 2004				
EB-4: Screener #1	07:41	2.4	7.0	47.7
EB-2: Screener #1	07:30	1.2	17.9	41.9
EB-1: Screener #1	07:36	4.3	14.0	51.3
MU-2: Screener #1	07:08	0.3	3.5	15.0
MU-1: Screener #1	07:16	1.0	5.7	25.2
SE-4: Screener #1	06:50	0.7	3.3	17.3
SE-3: Screener #1	05:15	0.4	3.6	17.1
SE-1: Screener #1	06:41	33.3	52.3	224.0

WB=West Baggage; EB=East Baggage; MU=East Remote; SE=Southeast Baggage

Dosimeter data for TSA employees working at the baggage screening machines. Sampling time is reported as the hours and minutes that the device was on the worker. All percent dose criteria, permissible exposure limit (PEL), action level (AL), and recommended exposure limit (REL), have been extrapolated to an 8-hr time-weighted average for each worker.

Figure 1
TSA-Washington Dulles International Airport
WB-1 Baggage Screener #2
HETA 2004-0100
Dulles, Virginia
July 12, 2004

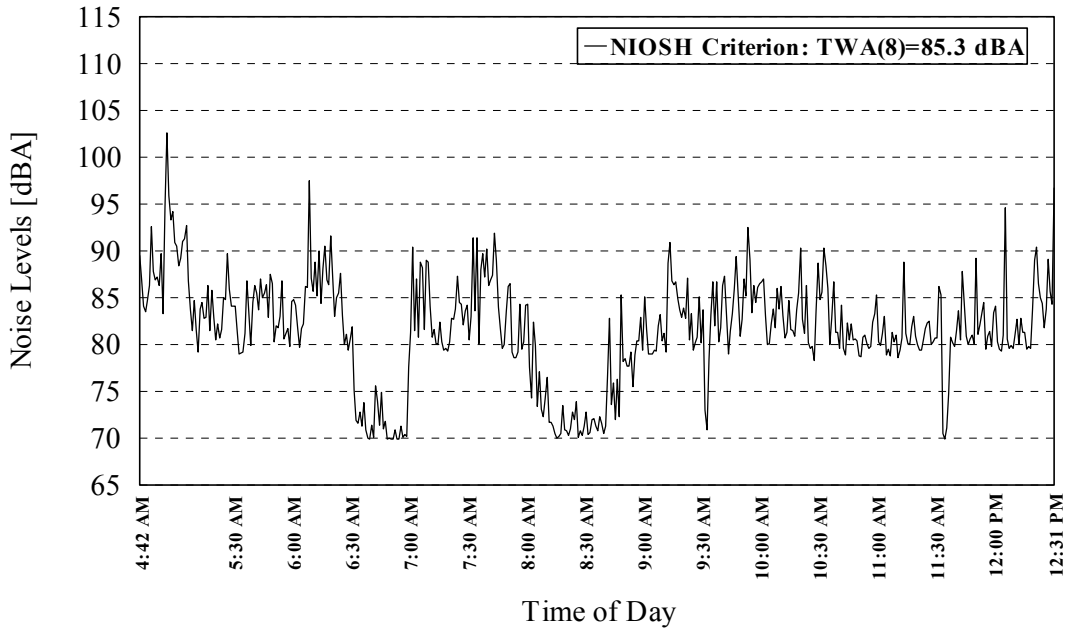


Figure 2
TSA-Washington Dulles International Airport
WB-2 Baggage Screener #1
HETA 2004-0100
Dulles, Virginia
July 12, 2004

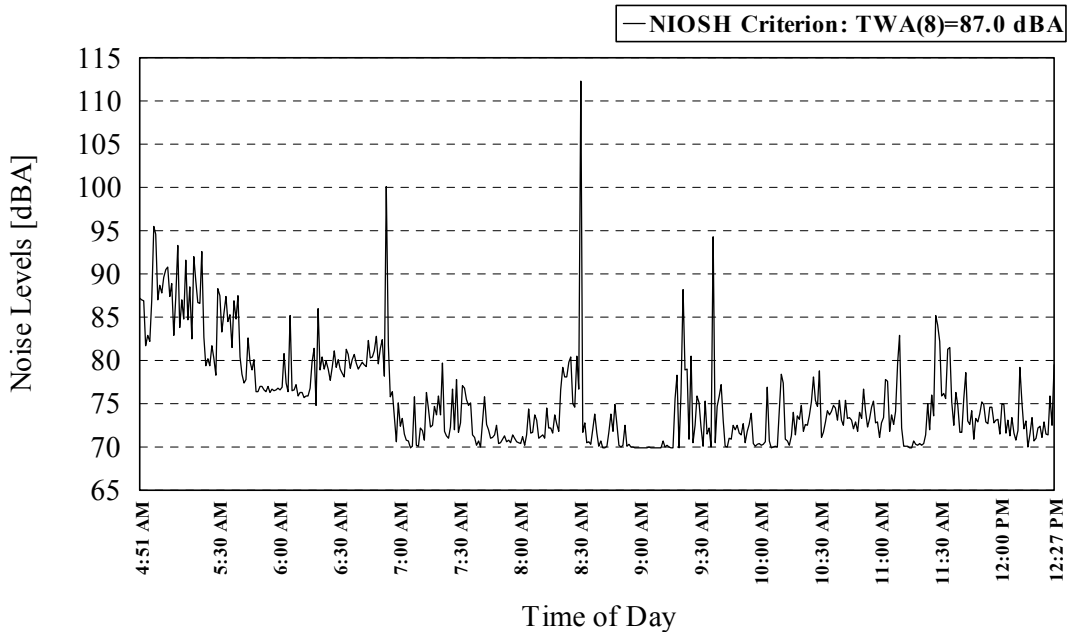


Figure 3
TSA-Washington Dulles International Airport
WB-3 Baggage Screener #2
HETA 2004-0100
Dulles, Virginia
July 12, 2004

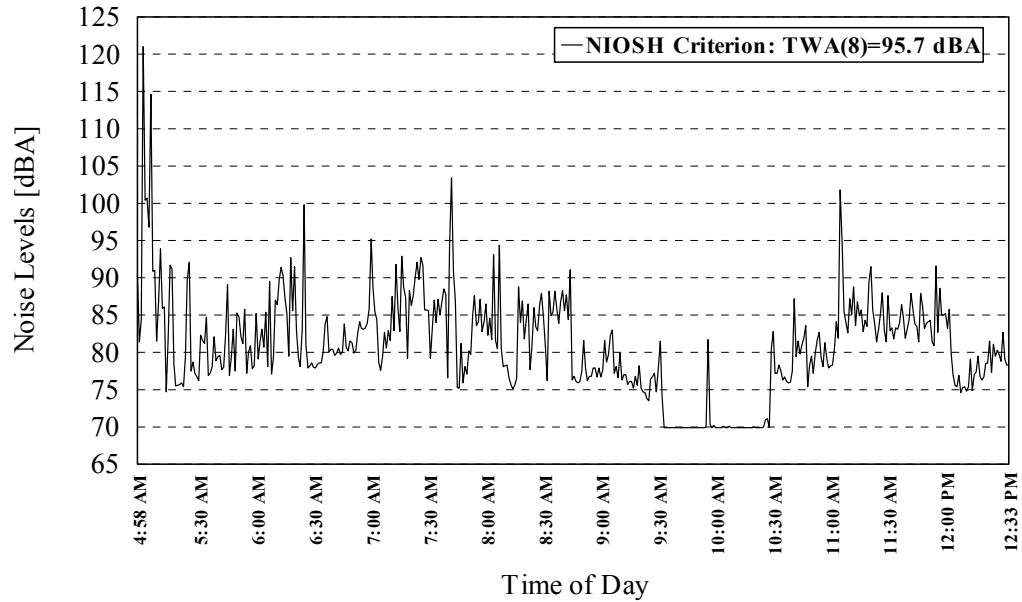


Figure 4
TSA-Washington Dulles International Airport
SE-1 Baggage Screener
HETA 2004-0100
Dulles, Virginia
July 13, 2004

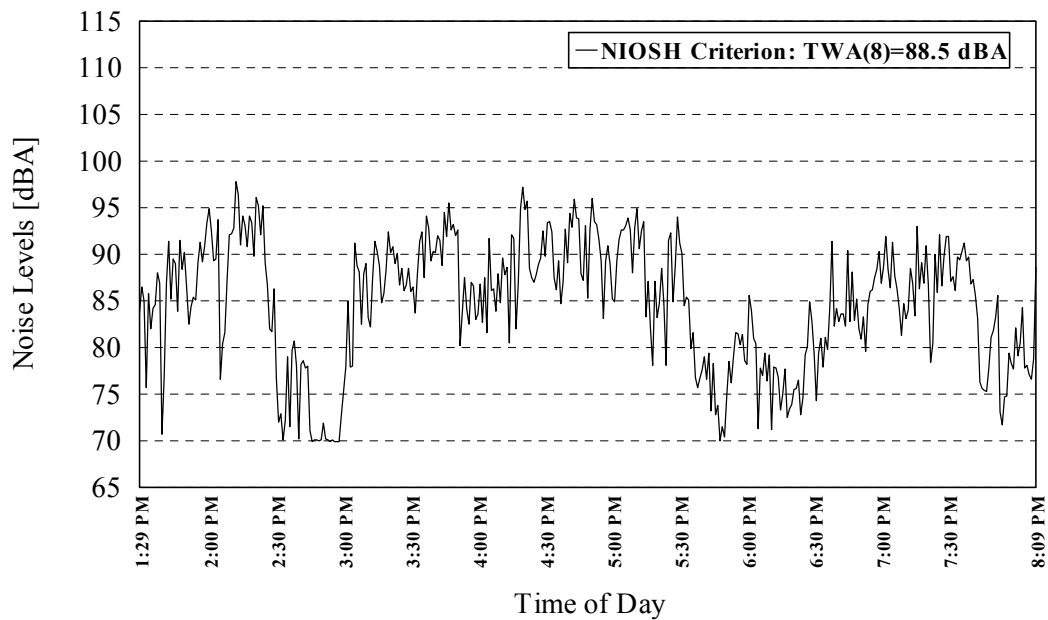
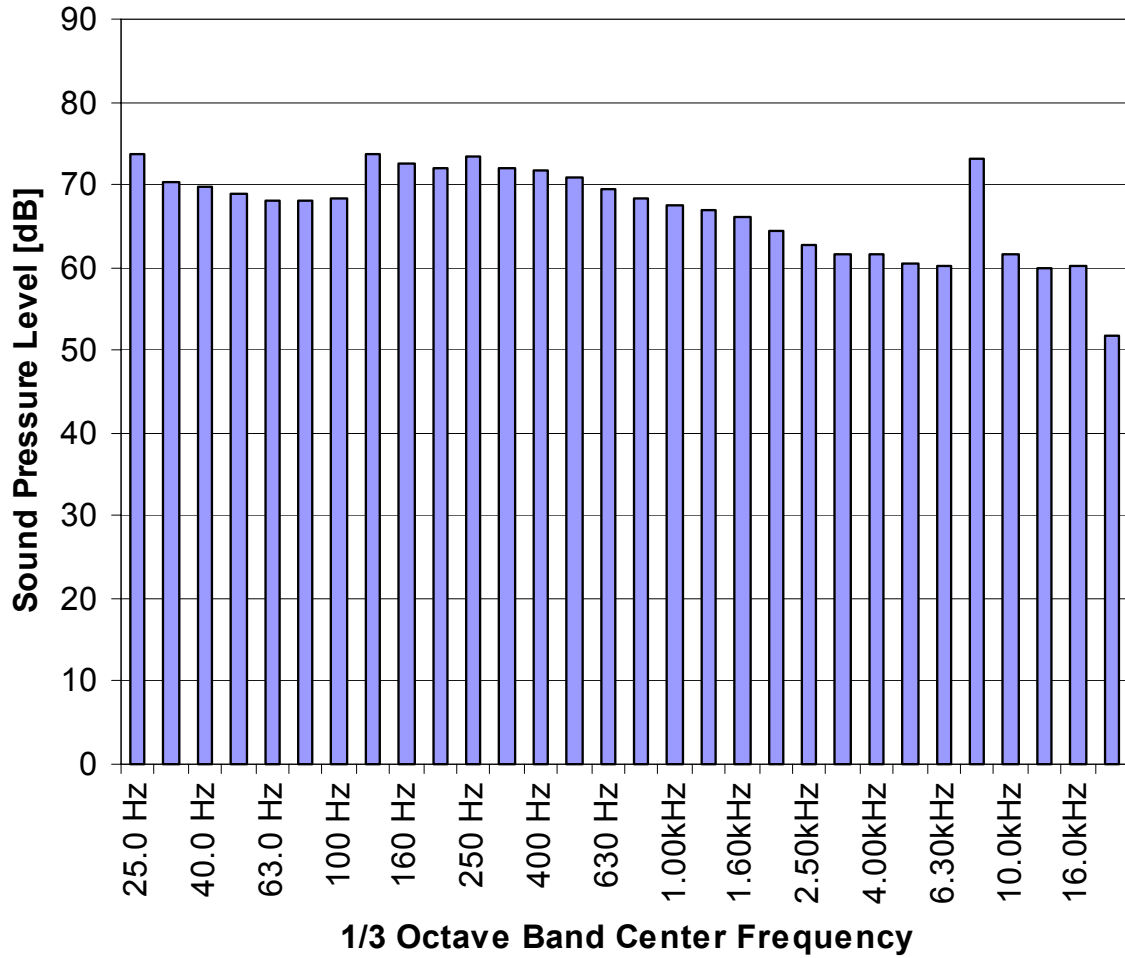
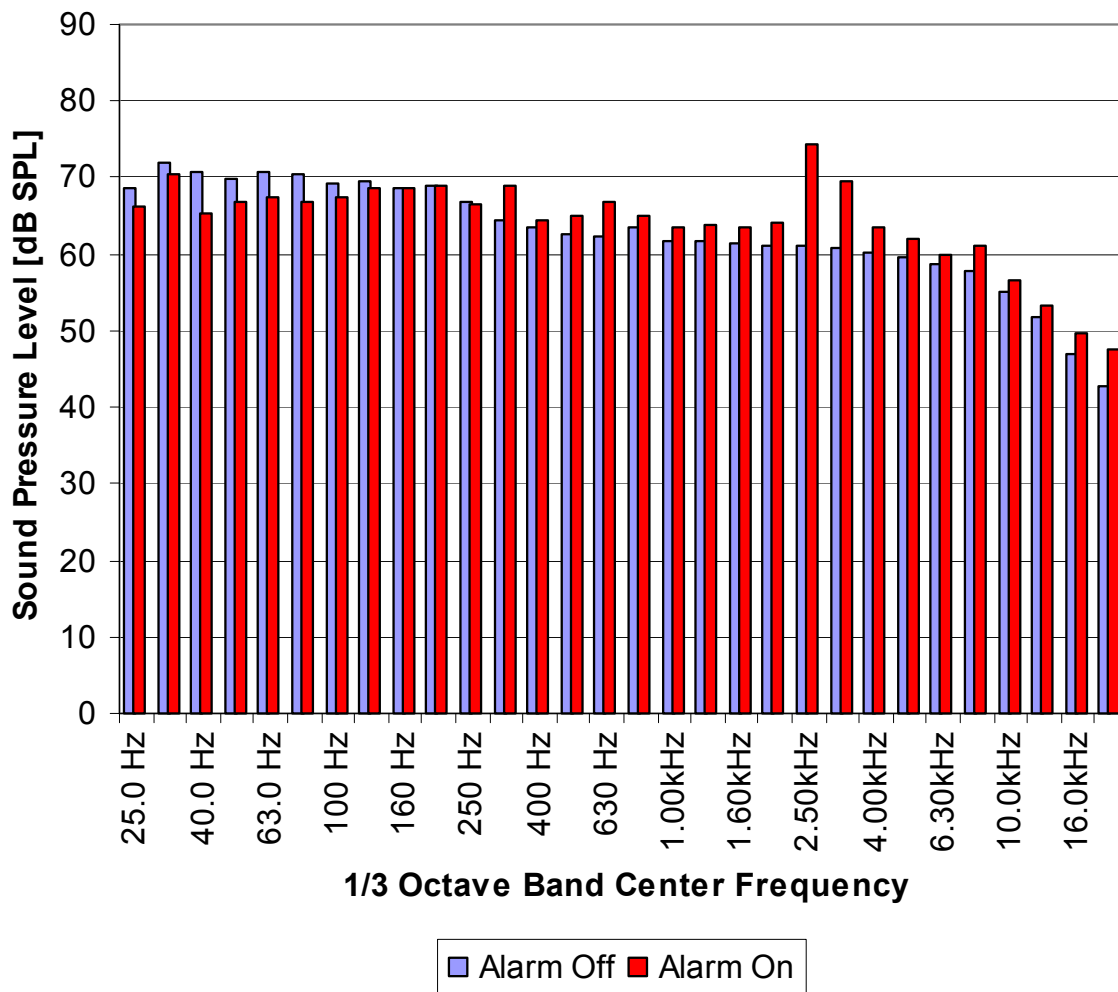


Figure 5
TSA -Washington Dulles International Airport
WB-2 Area Noise Sample – Input Side of EDS
HETA 2004-0100-2946
Dulles, Virginia
July 13, 2004



One-third octave band noise levels measured at the input side of the EDS WB-2. The 8.0 kHz band at 73.2 dB SPL depicts the audible squeak heard in the baggage area coming from the baggage carousel.

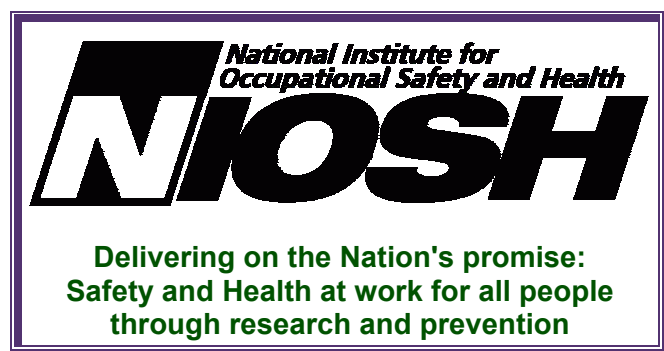
Figure 6
TSA -Washington Dulles International Airport
East baggage Remote (MU-2) Area Noise Samples
HETA 2004-0100-2946
Dulles, Virginia
July 13, 2004



One-third octave band noise levels measured at the input side of the EDS ER-2 when the alarm was sounding (red bar) and when the alarm was off (blue bar). The alarm's predominant frequency is centered at 2.5 kHz. Overall, the measured noise levels were 78.8 dBA with the alarm on and 73.2 dBA with the alarm off.

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Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, OH 45226-1998

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